

Which ies/eulumdat fits the  
given geometry of street  
lighting best?

Searching from thousands  
of luminaire photometries

presented by Jan Hollan

from

CzechGlobe – Global Change Research Centre (of Acad.  
Sci. Czech Rep.)

AdMaS - Advanced Materials, Structures and Technologies  
Centre of the Brno University of Technology

and

Department of Preventive Medicine, Masaryk University, Brno

# Outdoor lights: why any?

- For visual maritime or inland ship navigation: **faint enough to minimize loss of adaptation.** Other lights unwanted.
- For marking unexpected, temporary obstacles to pedestrians or drivers – dtto
- For making travelling easier in difficult, little known places – hand-held lantern, ...

To ease walking to unadapted people coming from lit indoors

- (strong indoors: need more outdoors too)

Our goal:  
minimizing light amounts at  
night, incl. wiping out light  
serving no purpose

- Not just because man-made light is pollutant at night, outdoors (see the **Declaration**).
- But also because we have no sustainable electricity for that, not even is it in sight...
- Current electricity consumption is **immoral**, destroying the planet to future generations

# Luminaires with luminous intensity distributions optimised for the exact lighting task are to be used

- selected from the whole pool of the world market with them
- However, usual practice is to adhere to a single producer, if not a single luminaire type with its basic optical configuration

# To be able to “read” photometric properties, I wrote **ies2tab**

- Beside a simple table of cd/klm, some info is computed:

Source file: ies/35617.ies

Luminaire flux = 5371 lm, 82.6 % of the bulb flux

between 75 and 90: 9.7 % of the luminaire flux

- **this part causes just GLARE in case of road lighting** and similar purposes

80deg and above: max 370.0 cd / 1000 lm , 3.1 % of the luminaire flux

90deg and above: max 3.0 cd / 1000 lm , 0.5 % of the luminaire flux

CutOff Type: Non-CutOff

# maxima reported:

62.5 deg to <67.5 deg: 398 cd / 1000 lm,

67.5 deg to < 76 deg: 997 cd / 1000 lm,

maximum specific luminous Intensity: 997 cd / 1000 lm

## And the source data labelled:

# H: 0.0 5.0 15.0 25.0 35.0 45.0 52.5 55.0 57.5 62.5 ...

#V:

0.0 46.0 46.0 46.0 46.0 46.0 46.0 46.0 46.0 46.0 46.0 ...

5.0 46.0 48.0 82.0 102 84.0 87.0 94.0 96.0 102 112 ...

15.0 98.0 108 112 165 166 162 162 162 163 165 ...

25.0 137 108 162 182 184 187 182 181 182 183 ...

...

# Increase of sky luminance due to direct uplight

Increase of Sky Luminance due to light going from the luminaire directly above horizon, as compared with the luminance produced by the light dispersed from the ground:

13 %

Increase of Sky Luminance in Distant Places by light below 15.0 degrees due to light going from the luminaire directly above horizon: 49 % (for the zenith luminance such an angle suits places up to 19 km distance)

The increases concern the following situation:

Albedo = 0.10

Zenith Extinction = 0.30 mag (i.e., direct light remaining 76 %)

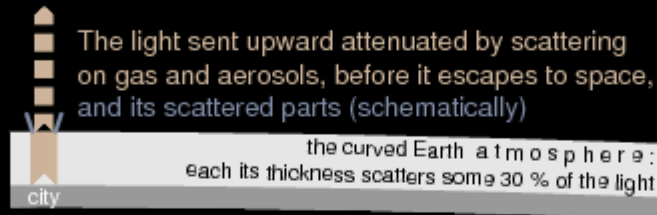
Indicatrix type = 0 (0: acc. to P.Cinzano, 4..6: CIE sky types)

(the downward-scattered part of lambertian uplight is 0.1108 then)

## Why the sky over your town and even far from it glows so much?

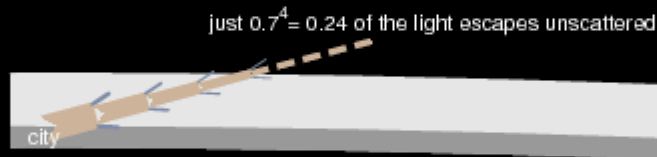
When the light from lamps or illuminated surfaces goes:

@ 90 degrees upwards:  
30 % scatters,  
from 28 % downwards,  
altogether it returns down just  
8 % of such light,

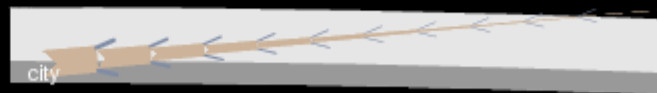


Sum of the light scattered by the air and its true directions – mostly similar to the original direction

@ 15 degrees upwards:  
76 % scatters,  
from 40 % downwards,  
altogether it returns down  
31 % of such light,



@ 5 degrees upwards:  
97 % scatters,  
from 45 % downwards,  
altogether it returns down  
45 % of such light.



Which of the cases given above contributes most to the skyglow, in your opinion?



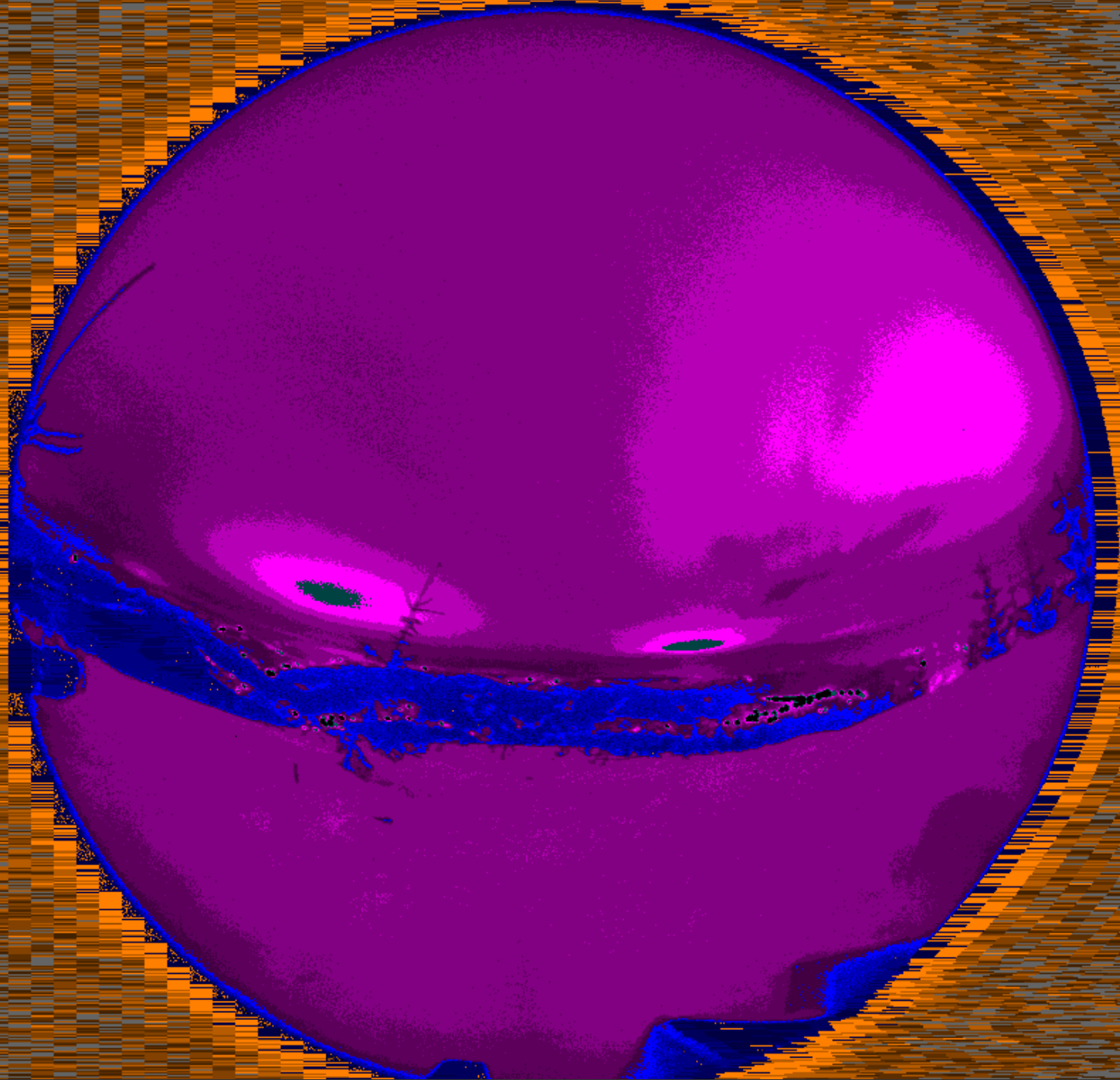
# Jungle of photometry conventions and misconceptions

IES (A, B, C)

Eulumdat

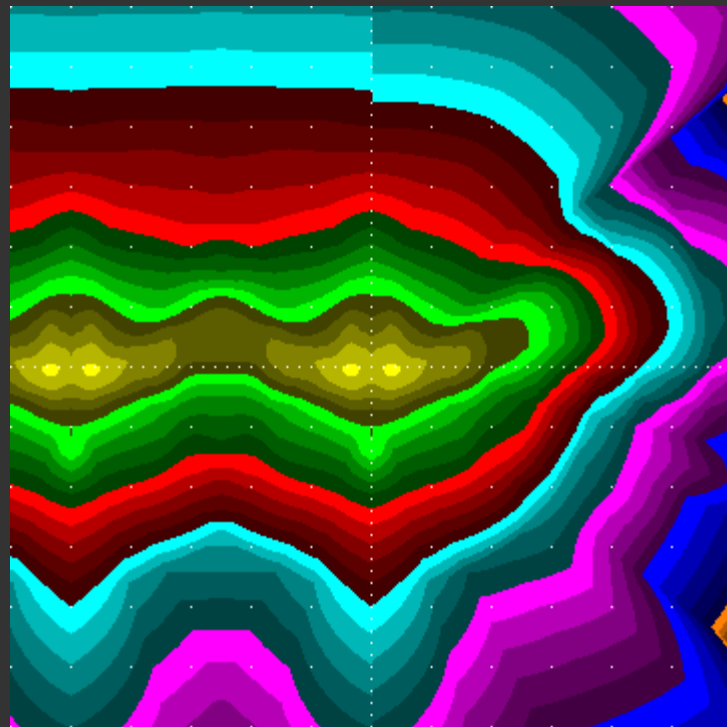
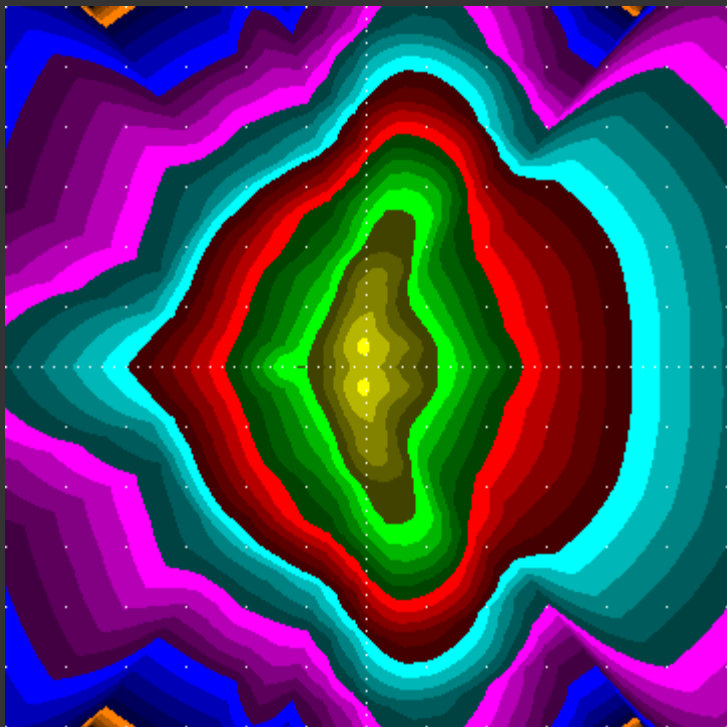
provides conversions to each other

and can visualize ground illuminance to see  
what's the problem, e.g., how to rotate the file



single

row spaced 5 heights

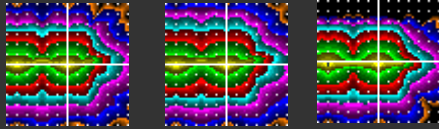


0,000 1 0,001 0,01 0,1 0,4 0,6 1 1,6 2,5 10 100 1 000 10 000

# Scripts for sorting, this for maximum specific luminous intensity at 67.5 to <72.5, from the database of Diego Bonata

#Fi0ut	75-90	>= 80degrees		>= 90degrees			65	70	abs.	Cut0ff?	filename
#	%	cd/klm	% Out	cd/klm	% Out	% ILP.	max.	cd/klm			
73.3	0.4	6.7	0.0	0.0	0.0	0	1861	1901	1901	Full_Cut0ff	RRAQ45
72.4	0.8	14.6	0.1	0.0	0.0	0	1370	1677	1677	Full_Cut0ff	RRAQ55
72.5	0.4	6.6	0.0	0.0	0.0	0	2233	1667	2233	Full_Cut0ff	RRAQ33
72.1	0.8	16.2	0.1	0.0	0.0	0	1568	1577	1577	Full_Cut0ff	RRAQ43
72.8	0.5	7.2	0.0	0.0	0.0	0	1767	1505	1767	Full_Cut0ff	RRAQ44
71.9	1.3	19.9	0.1	0.0	0.0	0	1074	1496	1496	Full_Cut0ff	RRAQ54
70.9	1.9	61.0	0.1	0.0	0.0	0	798	1464	1464	Full_Cut0ff	RRAQ53
71.0	0.6	6.1	0.0	0.0	0.0	0	1337	1436	1436	Full_Cut0ff	RRAQ32
73.4	0.2	3.9	0.0	0.0	0.0	0	2325	1435	2325	Full_Cut0ff	RRAQ34
69.2	0.5	4.2	0.0	0.0	0.0	0	1227	1358	1358	Full_Cut0ff	RRAQ21
73.3	0.2	3.7	0.0	0.0	0.0	0	2176	1351	2176	Full_Cut0ff	RRAQ23
77.8	1.3	13.7	0.4	0.0	0.0	0	1181	1274	1274	Full_Cut0ff	RRAY45
68.6	1.1	8.7	0.1	0.0	0.0	0	934	1214	1214	Full_Cut0ff	RRAQ31
71.4	0.3	2.9	0.0	0.0	0.0	0	1625	1200	1625	Full_Cut0ff	RRAQ22
73.5	0.2	2.9	0.0	0.0	0.0	0	2086	1191	2086	Full_Cut0ff	RRAQ35
72.6	1.9	50.8	0.1	0.0	0.0	0	709	1172	1172	Full_Cut0ff	RRAQ65
77.3	1.0	11.9	0.4	0.0	0.0	0	1574	1158	1574	Full_Cut0ff	RRAY34
75.6	1.7	22.9	0.5	0.0	0.0	0	1051	1153	1153	Full_Cut0ff	RRAY43
73.2	1.3	12.4	0.4	0.0	0.0	0	1235	1119	1235	Full_Cut0ff	RRAY32
77.7	0.9	10.4	0.3	0.0	0.0	0	1344	1115	1344	Full_Cut0ff	RRAY35
75.8	1.1	11.9	0.4	0.0	0.0	0	1479	1111	1479	Full_Cut0ff	RRAY33
77.2	1.4	20.0	0.4	0.0	0.0	0	1113	1105	1113	Full_Cut0ff	RRAY44
70.2	2.7	54.6	0.2	0.0	0.0	0	528	1089	1089	Full_Cut0ff	RRAQ52

See **thumbnails** online



# 5 heights, road from 0.1 to 0.8 h

Luminaires are sorted according to decreasing fraction of their light which hits a rectangle of  $-2.5:2.5:-0.8:-0.1$  pole heights (relative to all emissions from them). This html file has been created by `rect_il.sh` script (see `../scripts_bat`), then just 400 photometries were kept – those which provided less than 30 lx (1 m pole height, 1000 lm bulb, what corresponds to 1.2 lx with 5 m pole height) were discarded. Then the file has been sorted according to the above-mentioned useful fraction.

Ev. rotation of the luminaire needed to maximize this value is indicated by the 1st column larger than 1: -- 2: 90, 3: 180 and 4: 270 degrees

% of Increase of Sky Luminance

due to light going from the luminaire above horizon, as compared with the luminance produced by the light dispersed from the ground concerns the following situation:

Albedo = 0.10

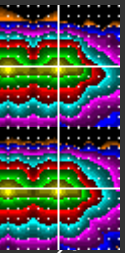
Zenith Extinction = 0.30 mag (i.e., direct light remaining 76 %)

Indicatrix type = 0 (0: acc. to P.Cinzano, 4..6: CIE sky types)

Calculation of the useful fraction of the outgoing luminous flux concerns a rectangle of  $-2.50:2.50:-0.80:-0.10$  pole heights illuminated by a row of luminaires spaced 5.00 pole heights; just luminaires closer than 12 pole heights are considered.

Grid is the same as for the illuminance plot, 1 point each 1/30 pole height.



	FiOut	75-90	>= 80degrees		>= 90degrees		65	70	abs.	CutOff?	useful/Out	Illum/lx(1m,1klm)			filename	
	%	%	cd/klm	% Out	cd/klm	% Out	% ILP.	max.	cd/klm		%	max	av	min	av/min	
	73.6	0.8	18.6	0.1	0.0	0.0	0	988	659	988	Full_CutOff	52.0	303.1	103.8	38.4	2.7 <b>RGAI12</b>
	71.9	0.7	10.5	0.1	0.0	0.0	0	892	596	892	Full_CutOff	52.2	306.4	101.7	33.4	3.0 RFAI12
	68.3	0.7	9.6	0.1	0.0	0.0	0	847	566	847	Full_CutOff	52.2	291.5	96.6	31.8	3.0 DMAI12LB
	75.4	0.7	12.6	0.1	0.0	0.0	0	899	599	899	Full_CutOff	51.7	276.0	105.7	32.4	3.3 RGAI24
	66.9	0.9	8.7	0.3	0.0	0.0	0	836	644	836	Full_CutOff	50.0	232.6	90.6	35.2	2.6 RRAH24

Most of the old market is at  
hand, thanks to Easy Light –  
Save The Sky

<http://www.savethesky.eu>

Now, the same is to be put  
together, and maintained, for  
LED lights...

You can inspect any luminaire  
online

Some Helios luminaire, 5 h, 100 W HPS,  
at 10 m...



# A tool for fixed geometry

- Diego Bonata's tool is for finding the best geometry for a luminaire, or a set of pre-selected luminaires.
- Pierantonio Cinzano's tool Roadpollution is for a detailed analysis of a single luminaire
- les2 package is for picking up the best luminaires out of all available photometries
- If they their light output can be dimmed by any amount, they might be good indeed

# What is to be sought for

- Is 0.3 lx enough?
- Then, anything more than that makes harm
- So, the average illuminance is a wrong parameter. Averages and maxima are to be as close to minima as technically possible
- And luminous intensity at 75 degrees or above is to be as low as possible. Steeper rays are easy to block by a peak=visor, or a hat.

# Let's build a modern photometry database

- And deny to promote any luminaire, whose photometry or its human-friendly complete output is not publicly available
- ies2 engine can make such human-friendly output from all ies/eulumdat files
- which may be offered further just by the manufacturers, this is what they prefer
- So, learn to work with ies2 and become experts in advising what luminaires to use in any given geometry of the lighting task!